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Gourley

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(54) **METHOD AND APPARATUS FOR MONITORING AND FILTERING UNIVERSAL SERIAL BUS NETWORK TRAFFIC**

(71) Applicant: **Cisco Technology, Inc.**, San Jose, CA (US)

(72) Inventor: **Christopher Shannon Gourley**, Sweetwater, TN (US)

(73) Assignee: **Cisco Technology, Inc.**, San Jose, CA (US)

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(52) **U.S. Cl.**
CPC ***G06F 21/56*** (2013.01); ***G06F 21/567*** (2013.01)

(58) **Field of Classification Search**
CPC G06F 15/16; G06F 11/00; G06F 12/14; G06F 21/00; G06F 21/56; G06F 21/567
USPC 726/24
See application file for complete search history.

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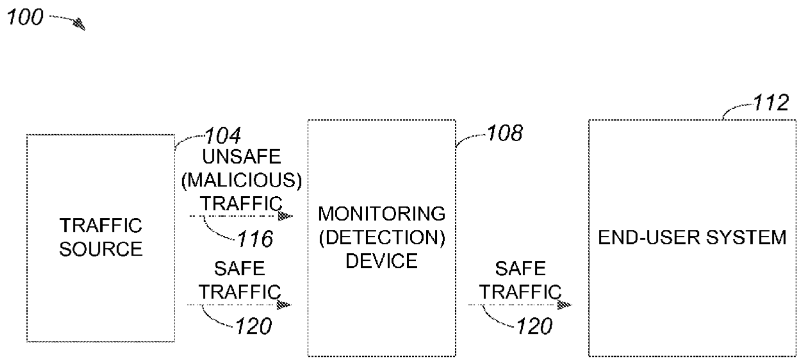
Primary Examiner — Jeffrey Pwu
Assistant Examiner — Samuel Ambaye
(74) *Attorney, Agent, or Firm* — P. Su

(57) **ABSTRACT**

In one embodiment, a method includes obtaining at least one packet from a first element on a Universal Serial Bus (USB) bus. The at least one packet is intended for a second element. The method also includes processing the at least one packet to determine whether the at least one packet is associated with unsafe content, and providing the at least one packet to the second element if it is determined that the at least one packet is not associated with the unsafe content. The at least one packet is provided to the second element on the USB bus. Finally, the method includes blocking the at least one packet from being provided to the second element when it is determined that the at least one packet is associated with the unsafe content.

16 Claims, 7 Drawing Sheets



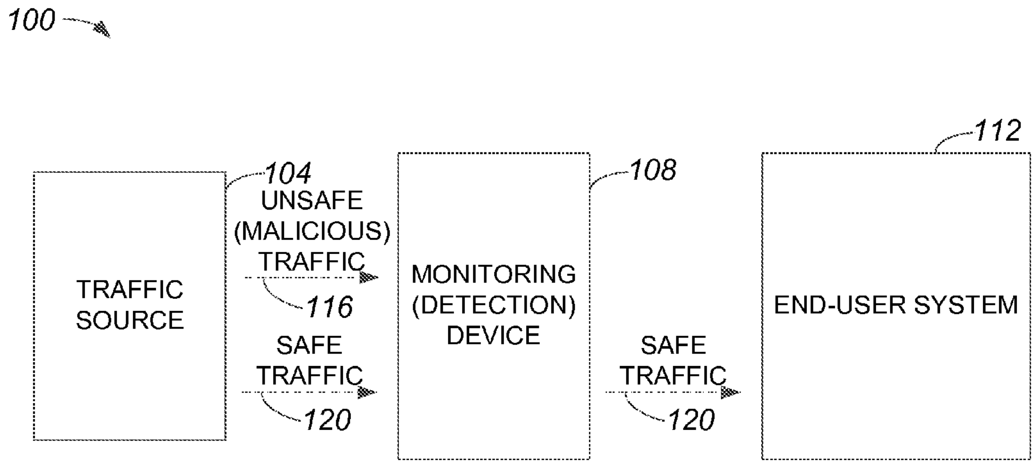

100
TRAFFIC SOURCE
104
UNSAFE (MALICIOUS) TRAFFIC
116
SAFE TRAFFIC
120
MONITORING (DETECTION) DEVICE
108
SAFE TRAFFIC
120
END-USER SYSTEM
112

FIG. 1

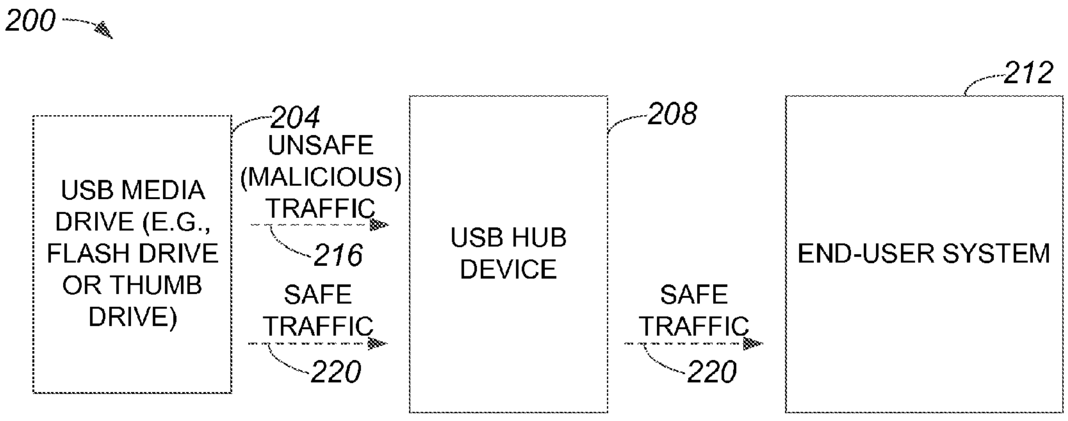

200
USB MEDIA DRIVE (E.G., FLASH DRIVE OR THUMB DRIVE)
204
UNSAFE (MALICIOUS) TRAFFIC
216
SAFE TRAFFIC
220
USB HUB DEVICE
208
SAFE TRAFFIC
220
212
END-USER SYSTEM

FIG. 2A

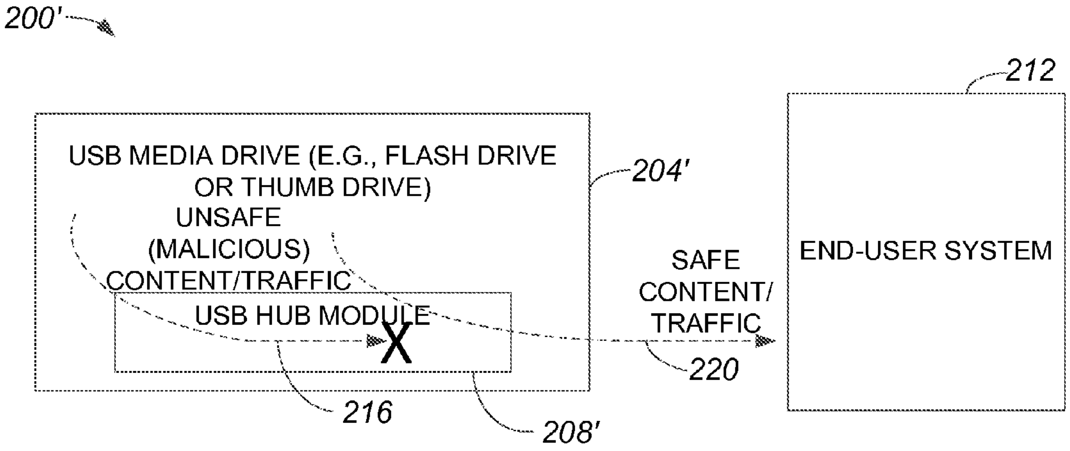

200'
USB MEDIA DRIVE (E.G., FLASH DRIVE OR THUMB DRIVE)
204'
UNSAFE (MALICIOUS) CONTENT/TRAFFIC
USB HUB MODULE
X
216
208'
SAFE CONTENT/ TRAFFIC
220
212
END-USER SYSTEM

FIG. 2B

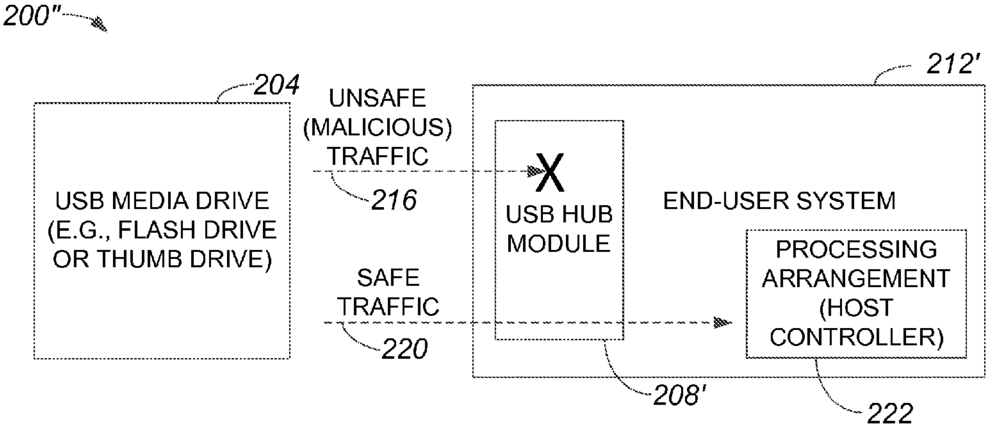

200"
204
USB MEDIA DRIVE
(E.G., FLASH DRIVE
OR THUMB DRIVE)
UNSAFE
(MALICIOUS)
TRAFFIC
216
X
SAFE
TRAFFIC
220
212'
USB HUB
MODULE
END-USER SYSTEM
PROCESSING
ARRANGEMENT
(HOST
CONTROLLER)
208'
222

FIG. 2C

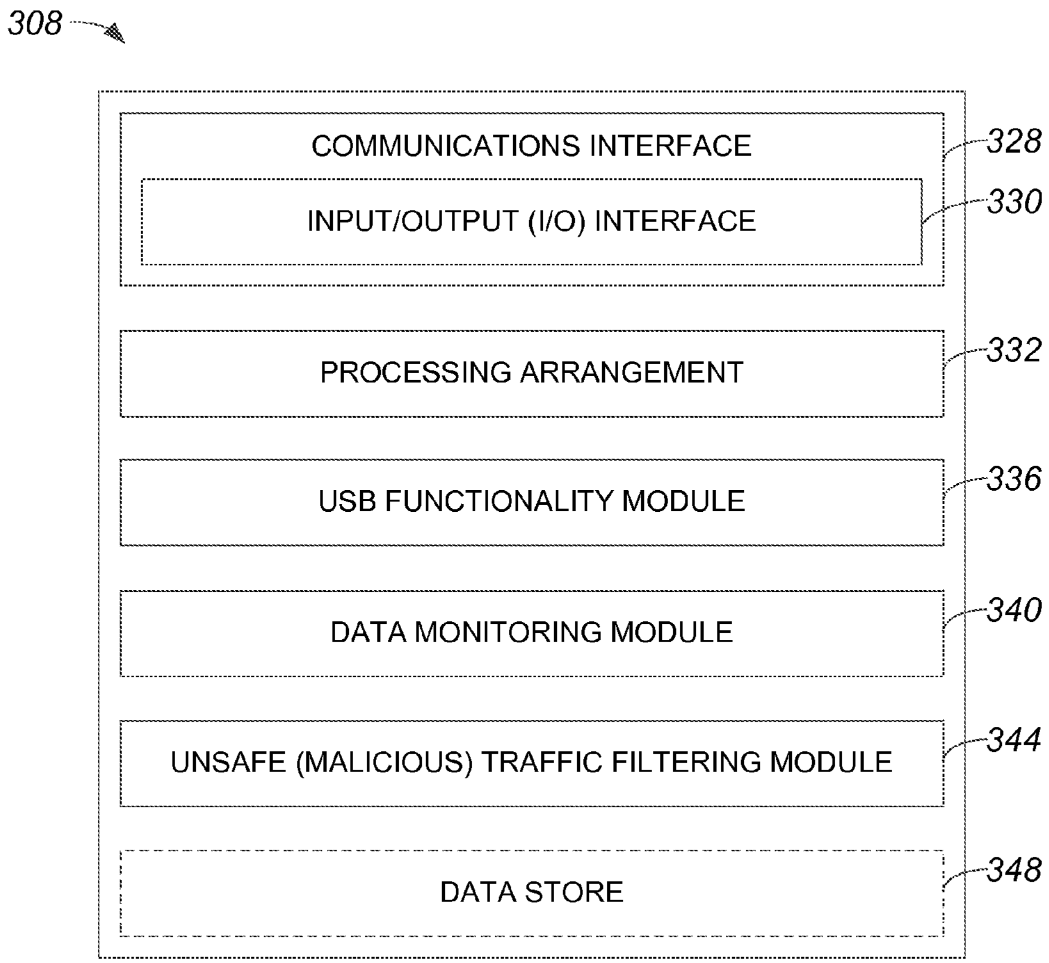

308
COMMUNICATIONS INTERFACE
328
INPUT/OUTPUT (I/O) INTERFACE
330
PROCESSING ARRANGEMENT
332
USB FUNCTIONALITY MODULE
336
DATA MONITORING MODULE
340
UNSAFE (MALICIOUS) TRAFFIC FILTERING MODULE
344
DATA STORE
348

FIG. 3

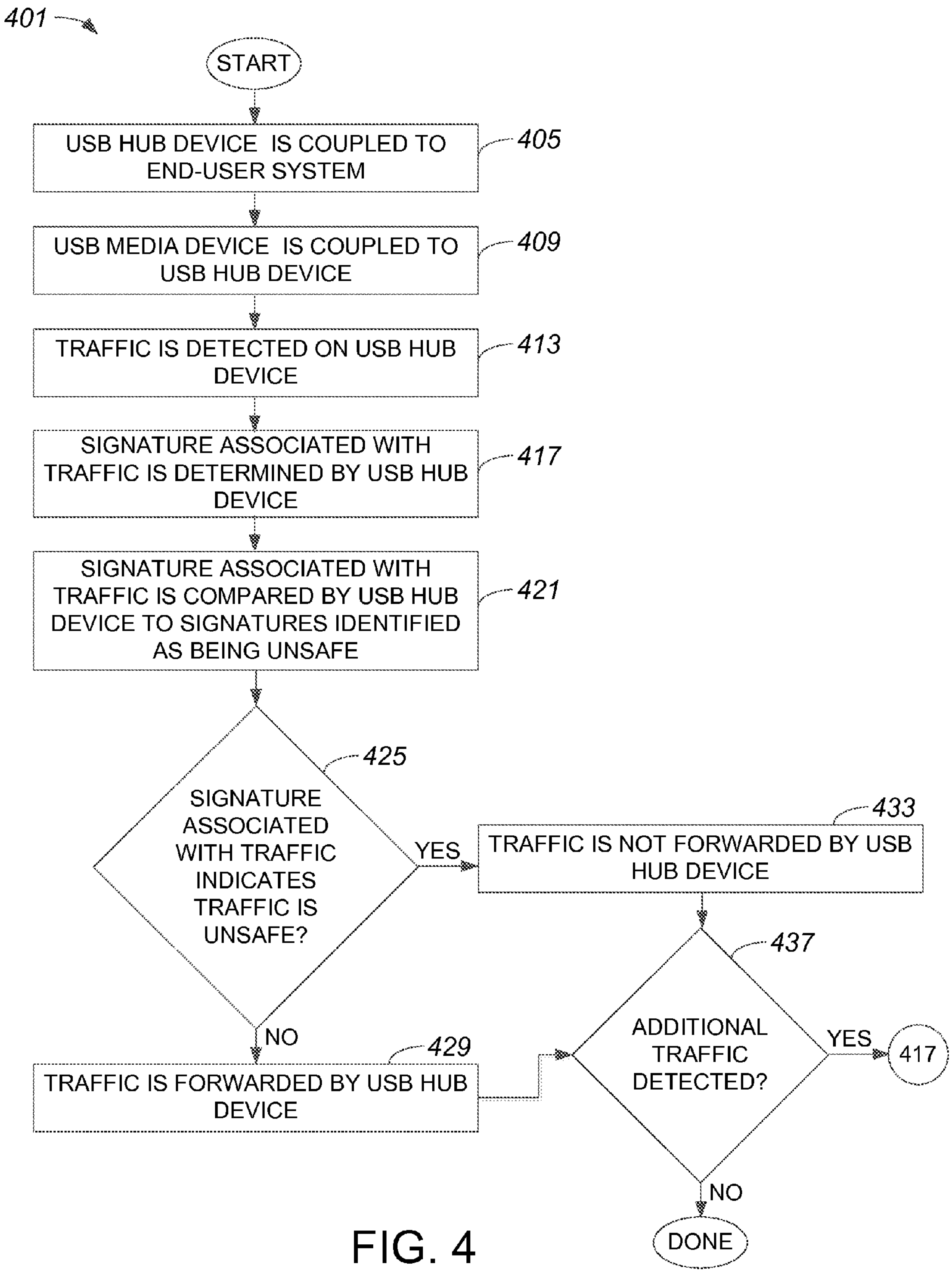

401
START
USB HUB DEVICE IS COUPLED TO END-USER SYSTEM
405
USB MEDIA DEVICE IS COUPLED TO USB HUB DEVICE
409
TRAFFIC IS DETECTED ON USB HUB DEVICE
413
SIGNATURE ASSOCIATED WITH TRAFFIC IS DETERMINED BY USB HUB DEVICE
417
SIGNATURE ASSOCIATED WITH TRAFFIC IS COMPARED BY USB HUB DEVICE TO SIGNATURES IDENTIFIED AS BEING UNSAFE
421
425
SIGNATURE ASSOCIATED WITH TRAFFIC INDICATES TRAFFIC IS UNSAFE?
YES
TRAFFIC IS NOT FORWARDED BY USB HUB DEVICE
433
NO
TRAFFIC IS FORWARDED BY USB HUB DEVICE
429
437
ADDITIONAL TRAFFIC DETECTED?
YES
417
NO
DONE

FIG. 4

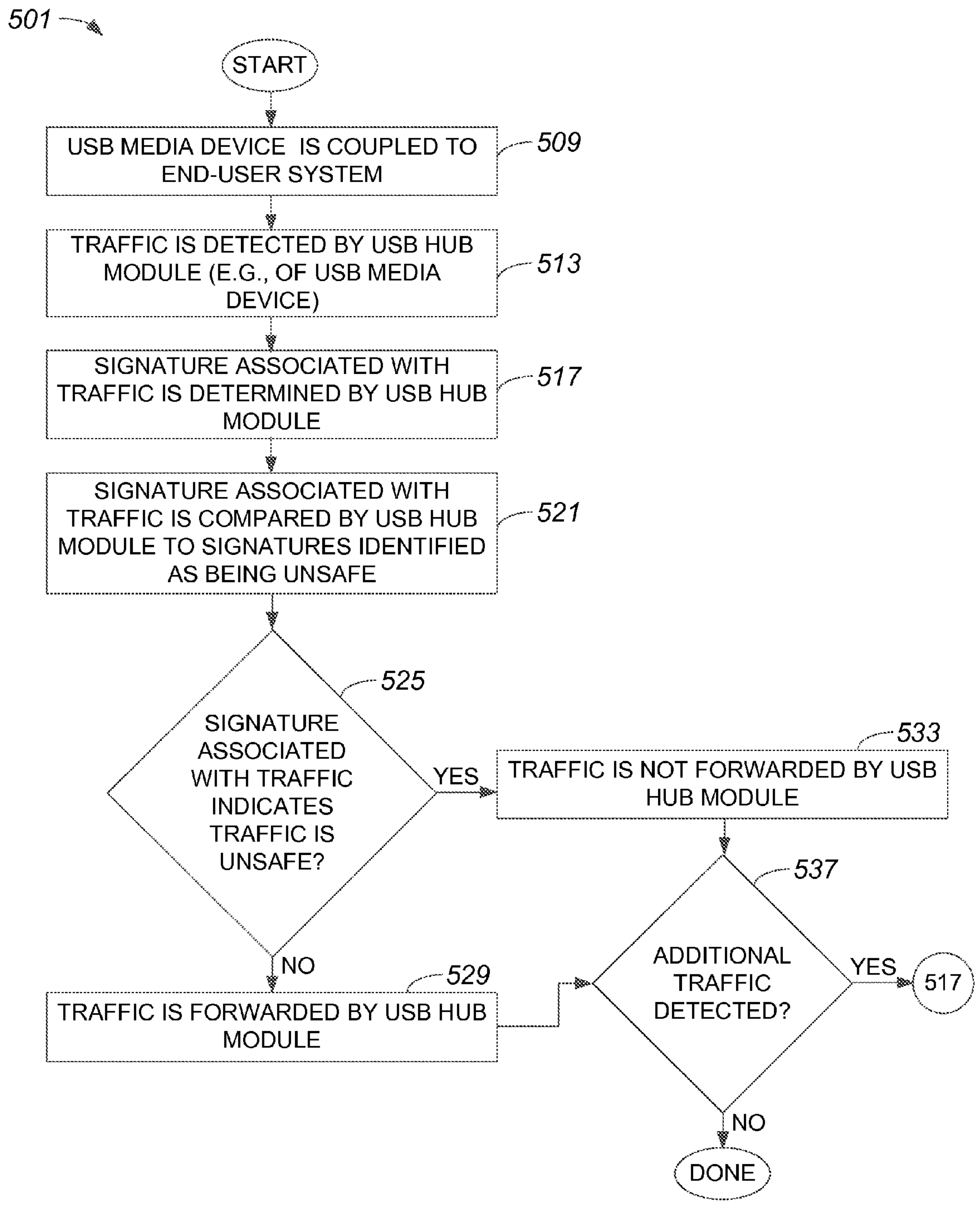

501
START
USB MEDIA DEVICE IS COUPLED TO END-USER SYSTEM
509
TRAFFIC IS DETECTED BY USB HUB MODULE (E.G., OF USB MEDIA DEVICE)
513
SIGNATURE ASSOCIATED WITH TRAFFIC IS DETERMINED BY USB HUB MODULE
517
SIGNATURE ASSOCIATED WITH TRAFFIC IS COMPARED BY USB HUB MODULE TO SIGNATURES IDENTIFIED AS BEING UNSAFE
521
525
SIGNATURE ASSOCIATED WITH TRAFFIC INDICATES TRAFFIC IS UNSAFE?
YES
533
TRAFFIC IS NOT FORWARDED BY USB HUB MODULE
NO
529
TRAFFIC IS FORWARDED BY USB HUB MODULE
537
ADDITIONAL TRAFFIC DETECTED?
YES
517
NO
DONE

FIG. 5

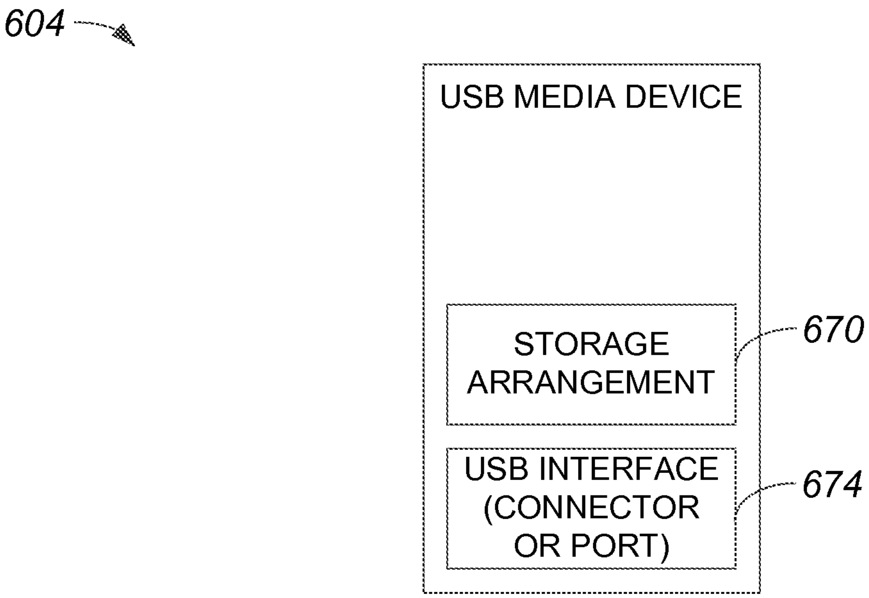

604
USB MEDIA DEVICE
STORAGE ARRANGEMENT
670
USB INTERFACE (CONNECTOR OR PORT)
674

FIG. 6

METHOD AND APPARATUS FOR MONITORING AND FILTERING UNIVERSAL SERIAL BUS NETWORK TRAFFIC

TECHNICAL FIELD

The disclosure relates generally to protecting computing systems from malicious software. More particularly, the disclosure relates to an appliance which detects and blocks malicious traffic on a Universal Serial Bus (USB) bus before the malicious traffic may pass between the appliance and a computing system.

BACKGROUND

When malicious traffic is passed to a computing system, the integrity of the computing system may be compromised. For example, viruses, malware, and/or other malicious software contained in traffic may undermine the operation of a computer system if allowed to pass to the computer system.

Typically, in order to protect a computing system, e.g., an end-user system, from malicious traffic, software may be executed on the computing system to determine when traffic received on the computing system includes malicious content. While such software may be effective in identifying traffic received on a computing system that includes malicious content, vulnerabilities in lower level systems and/or drivers of the computing system may be exploited by the malicious content before software executed on the computing system identifies the malicious content. For example, a virus which affects a lower level system associated with an end-user system may effectively infect the lower level system before the virus is detected by the end-user system.

A source of traffic may be a media device that effectively stores the traffic, e.g., packets, and such traffic may effectively be uploaded to an end-user system. When such a media device contains malicious content, the malicious content may be uploaded to an end-user system and may affect systems associated with the end-user system before the content is identified as being malicious.

BRIEF DESCRIPTION OF THE DRAWINGS

The disclosure will be readily understood by the following detailed description in conjunction with the accompanying drawings in which:

FIG. **1** is a diagrammatic representation of an overall system in which a monitoring appliance or device that monitors and filters Universal Serial Bus (USB) traffic is coupled between a source of traffic and an end-user system in accordance with an embodiment.

FIG. **2**A is a diagrammatic representation of an overall system in which a USB hub device that monitors and filters USB traffic is coupled between a source of traffic and an end-user system in accordance with an embodiment.

FIG. **2**B is a diagrammatic representation of an overall system in which a USB media device includes a USB hub module that monitors and filters USB traffic in accordance with an embodiment.

FIG. **2**C is a diagrammatic representation of an overall system in which an end-user system includes a USB hub module that monitors and filters USB traffic in accordance with an embodiment.

FIG. **3** is a block diagram representation of a USB hub device in accordance with an embodiment.

FIG. **4** is a process flow diagram which illustrates one method of monitoring and filtering USB traffic using a USB hub device in accordance with an embodiment.

FIG. **5** is a process flow diagram which illustrates one method of monitoring and filtering USB traffic using a USB hub module, e.g., a USB hub module installed on a USB media device, in accordance with an embodiment.

FIG. **6** is a block diagram representation of a USB media device in accordance with an embodiment.

DESCRIPTION OF EXAMPLE EMBODIMENTS

General Overview

According to one aspect, a method includes obtaining at least one packet from a first element on a Universal Serial Bus (USB) bus. The at least one packet is intended for a second element. The method also includes processing the at least one packet to determine whether the at least one packet is associated with unsafe content, and providing the at least one packet to the second element if it is determined that the at least one packet is not associated with the unsafe content. The at least one packet is provided to the second element on the USB bus. Finally, the method includes blocking the at least one packet from being provided to the second element when it is determined that the at least one packet is associated with the unsafe content.

Description

Protecting a computing system, as for example an end-user system, from viruses, malware, and/or other malicious software allows the integrity of the computing system to be preserved. Often, malicious traffic passes over a Universal Serial Bus (USB) bus between a host USB system, e.g., an end-user system, and a USB client device, e.g., a USB media device. While a host USB system may detect when viruses, malware, and/or other malicious software is present on the host USB system, the viruses, malware, and/or other malicious software may already be attacking the host USB system when detected. For example, a device driver may effectively be attacked by viruses, malware, and/or other malicious software before the host USB system is able to detect the viruses, malware, and/or other malicious software. When the malicious traffic reaches the host USB system before the malicious traffic is detected, the integrity of the host USB system may be compromised.

By providing a substantially standalone appliance or device that connects to a USB bus and monitors traffic intended for a computing system, the standalone appliance may identify malicious content and prevent the malicious content from adversely affecting the computing system. The standalone appliance may effectively serve as a firewall, an intrusion detection system (IDS) and/or an intrusion prevention system (IPS) that prevents malicious content from reaching the computing system, e.g., a system which contains a USB host controller. When the standalone appliance determines that particular content is malicious, the standalone appliance may be able to alert a user of the computing system that traffic intended for the computing system includes malicious content before the malicious content has effectively reached the standalone appliance. In addition, the standalone appliance may prevent or block the malicious content from reaching the computing system.

A standalone appliance may compare traffic against signatures of known viruses, malware, and/or malicious software, and determine whether the traffic is malicious, or includes malicious content. When traffic is identified as being malicious, the standalone appliance may alert a user of an end-user system for which the traffic was intended, and otherwise prevent the traffic from reaching the end-user system. In one embodiment, the standalone appliance may operate at a lowest USB protocol or packet level. It should be appreciated that in lieu of comparing traffic against signatures of known viruses, malware, and/or malicious software, the traffic is not limited to being compared against signatures of known viruses, malware, and/or malicious software to identify malicious traffic. Any suitable method may generally be used by a standalone appliance to detect malicious traffic. By way of example, traffic may be processed to identify anomalies, and traffic containing anomalies may be classified as being malicious or at least potentially malicious.

Referring initially to FIG. **1**, an overall system in which a monitoring appliance or device that monitors and filters USB network traffic is coupled between a source of traffic and an end-user system in accordance will be described in accordance with an embodiment. An overall system **100** includes a traffic source **104**, a monitoring device **108**, and an end-user system **112**, e.g., a computer device. Monitoring device **108** may be a USB hub that is external with respect to end-user system **112**, and coupled to end-user system **112** and arranged to receive traffic **116**, **120** from traffic source **104**. In one embodiment, traffic source **104** may be coupled to monitoring device **108** such that monitoring device **108** is effectively in direct communication with traffic source **104** and end-user system **112**. Traffic source **104** may provide traffic **116**, **120** to monitoring device **108** that is intended for end-user system **112**, and end-user system **112** may provide traffic (not shown) to monitoring device **108** that is intended for traffic source **104**.

Traffic source **104** may be any device or component that may be in communication with, e.g., physically coupled to, monitoring device **108**. In one embodiment, traffic source **104** either includes a connector (not shown) that interfaces with a receptacle (not shown) of monitoring device **108**, or includes a receptacle (not shown) that interfaces with a connector (not shown) of monitoring device **108**. It should be appreciated that in some instances, traffic source **104** may be in wireless communication with and, therefore, communicably coupled to but not physically coupled to monitoring device **108**.

Monitoring device **108** is generally arranged to process traffic **116**, **120** to identify safe traffic **120** and unsafe, or malicious, traffic **116**. Monitoring device **108** obtains traffic **116**, **120**, and upon identifying safe traffic **120** and unsafe traffic **116**, may provide safe traffic **120** to end-user system **112** and prevent unsafe traffic **116** from being provided to end-user system. Any suitable method may be used by monitoring device **108** to identify safe traffic **120** and unsafe traffic **116** by comparing signatures associated with traffic **116**, **120** to known signatures of unsafe content, e.g., known signatures of viruses and/or malware. The signatures may be stored on monitoring device **108**, and may be periodically updated by monitoring device **108**. Updating the signatures may include, but is not limited to including, obtaining current signatures from a data repository (not shown) that is accessible to monitoring device **108**.

In one embodiment, monitoring device **108** may be a USB hub device that monitors and filters USB traffic. FIG. **2**A is a diagrammatic representation of an overall system in which a USB hub device that monitors and filters USB traffic is coupled between a source of traffic and an end-user system in accordance with an embodiment. An overall system **200** includes a USB device **204** which, in the described embodiment, is a USB media drive **204**. System **200** also includes a USB hub device **208** and an end-user system **212**, e.g., a computer device with a USB host controller (not shown).

USB media drive **204**, which may be a flash drive or a thumb drive, may be coupled to USB hub device **208** and may provide unsafe USB network traffic **216** and safe USB network traffic **220** to USB hub device **208**. It should be appreciated that USB media drive **204** is not limited to being a flash drive or a thumb drive. In other words, USB media drive **204** may generally be any suitable device that stores data or traffic, and is arranged to engage in USB communications.

USB hub device **208** is generally configured to identify and to filter out unsafe traffic **216** using any suitable method, and to prevent unsafe traffic **216** from passing to end-user system **212** while allowing safe traffic **220** to pass to end-user system **212**. USB media drive **204** may include a connector (not shown) that interfaces with a receptacle (not shown) of USB hub device **208**, or may include a receptacle (not shown) that interfaces with a connector (not shown) of USB hub device **208**.

The functionality implemented by USB hub device **208**, e.g., the functionality that allows unsafe traffic **204** to be identified and effectively prevented from reaching end-user system **212**, may be provided, in one embodiment, on a USB media drive rather than on USB hub device **208**. That is, a USB media drive may include functionality which identifies unsafe, or malicious, content and prevents that content from being provided to an end-user system when the USB media drive is interfaced with the end-user system.

An embodiment in which the ability to monitor traffic content, or contents of packets included in traffic, may be provided in a USB media device which is also a source of USB network traffic will be described with respect to FIG. **2**B. FIG. **2**B is a diagrammatic representation of an overall system in which a USB media device includes a USB hub module that monitors and filters USB traffic in accordance with an embodiment. An overall system **200'** includes a USB media drive **204'** that is in communication with, e.g., physically interfaced with, an end-user system **212**. USB media drive **204'**, which may be a flash drive or a thumb drive, includes a USB hub module **208'** that is arranged to monitor and to process content or traffic **216**, **220** that is to effectively pass from USB media drive **204'** to end-user system **212**. USB hub module **208'** is configured to identify unsafe content or traffic **216**, and to prevent unsafe content or traffic **216** from passing to end-user system **212**. USB hub module **208'** is also configured to identify safe content or traffic **220**, and to allow safe content or traffic **220** to pass to end-user system **212**. USB hub module **208'** may, upon detecting that USB media drive **204'** is substantially interfaced with end-user system **212**, compare addresses associated with content or traffic **216**, **220** to known addresses of safe data to identify unsafe content or traffic **216** and to identify safe content or traffic **220**.

The functionality which effectively monitors USB network traffic to filter out unsafe or malicious traffic may, in one embodiment, be provided on an end-user system such that unsafe or malicious traffic may be identified before such traffic is passed to a processing arrangement, or a USB host controller, of the end-user system. An end-user system may, for example, have a built-in USB hub that provides more than one USB port. An end-users system with a built-in USB hub may include an integrated circuit chip that provides USB hub functionality. Functionality which effectively monitors USB network traffic to filter out unsafe or malicious traffic may be provided on an integrated circuit chip that provides USB hub functionality in an end-user system, in one embodiment. FIG. **2**C is a diagrammatic representation of an overall system in which an end-user system includes a USB hub module that monitors and filters USB traffic in accordance with an embodiment. An overall system **200''** includes a USB media drive **204** that is in communication with, e.g., physically interfaced with, an end-user system **212**.' USB media drive **204** may be a flash drive or a thumb drive, or any suitable device that is configured to engage in USB communications with end-user system **212'**.

A USB hub module **208'** is arranged to monitor and to process content or traffic **216**, **220** that is to effectively pass from USB media drive **204** to end-user system **212** when USB media drive **204** is in communication with end-user system **212'**. USB hub module **208'** is configured to obtain and to identify unsafe content or traffic **216**, and to prevent unsafe content or traffic **216** from passing to a processing arrangement **222** of end-user system **212'**. In other words, USB hub module **208'** is configured to identify unsafe traffic **216** such that unsafe traffic **216** may be prevented from being processed.

USB hub module **208'** is also configured to identify safe content or traffic **220**, and to allow safe content or traffic **220** to pass to processing arrangement **222** of end-user system **212'**. USB hub module **208'** may, upon detecting that USB media drive **204** is substantially interfaced with end-user system **212** and causing traffic to be sent to end-user system **212'**, compare signatures associated with content or traffic **216**, **220** to known signatures of safe data to identify unsafe content or traffic **216** and to identify safe content or traffic **220**.

As previously described, as for example with respect to FIG. **2**A, a USB hub device may serve as an interface between a USB media drive and an end-user system, and prevent unsafe USB network traffic associated with the USB media drive from reaching the end-user system. It should be appreciated that a USB hub device may also prevent unsafe USB network traffic associated with an end-user system from reaching a USB media drive. With reference to FIG. **3**, a USB hub device will be described in accordance with an embodiment. A USB hub device **308** is generally arranged to receive USB network traffic, or traffic received on a USB bus, and to identify unsafe content within the traffic such that the unsafe content may effectively be prevented from being provided to a destination, e.g., an end-user system.

USB hub device **308** includes a communications interface **328** that is generally arranged to engage in USB communications, or communications on a USB bus (not shown). Communications interface **328** includes an input/output (I/O) interface **330**. I/O interface **330** may include a port arrangement that includes a USB connector, a USB receptacle, and/or wires. I/O interface **330** may be configured to allow USB hub device **308** to be physically interfaced with a USB media drive and an end-user system.

USB hub device **308** also includes a processing arrangement **332** which includes at least one processor (not shown), and is configured to execute logic. Logic associated with a USB functionality module **336**, a data monitoring module **340**, and an unsafe traffic filtering module **344** may be executed by processing arrangement **332**.

USB functionality module **336** is arranged to allow USB hub device **308** to identify USB network traffic. In addition, USB functionality module **336** allows USB hub device **308** to process USB network traffic appropriately.

Data monitoring module **340** is arranged to process traffic obtained off of a USB bus (not shown) by communications

interface **328**, and to determine whether particular traffic is safe or unsafe. Data monitoring module **340** may obtain signatures and/or information relating to known unsafe data, e.g., viruses or malware, to compare with signatures associated with obtained traffic. In one embodiment, such signatures for known unsafe data may be obtained from an optional data store **348** that may be periodically updated to maintain a current list of signatures for known unsafe data. It should be appreciated, however, that data monitoring module **340** may instead obtain signatures for known unsafe data from any suitable external data source.

Safe traffic identified by data monitoring module **340** may effectively be forwarded to, or otherwise passed to, a destination through communications interface **328**. Unsafe traffic identified by data monitoring module **340** may effectively be prevented from being forwarded by unsafe or malicious traffic filtering module **344**. Unsafe or malicious traffic filtering module **344** may also provide a warning relating to unsafe traffic. By way of example, in addition to preventing unsafe traffic from reading an end-user system, unsafe or malicious traffic filtering module **344** may provide an indication to the end-user system that a USB media drive is attempting to load unsafe content onto the end-user system.

Referring next to FIG. **4**, one method of monitoring and filtering USB network traffic using a USB hub device will be described in accordance with an embodiment. A method **401** of monitoring and filtering USB network traffic begins at step **405** in which a USB hub device is coupled to an end-user system. For example, the USB hub device may be coupled to a USB port of the end-user system such that the USB hub device and the end-user system are arranged to communicate over a USB bus.

A USB media device or, more generally, a USB device is coupled to the USB hub device in step **409**. It should be appreciated that the USB media device may, instead, be coupled to the USB hub device prior to the USB hub device being coupled to an end-user system. The USB media device may, for example, be coupled to a USB port of the USB hub device such that the USB hub device and the USB media device may communicate over a USB bus.

Traffic, e.g., USB network traffic, is detected in step **413** by the USB hub device **413**. The traffic may generally be traffic that originates from the USB media device, although it should be appreciated that the traffic may instead be traffic that originates from the end-user system. Once the traffic is detected, a signature associated with the traffic is determined or otherwise identified by the USB hub device in step **417**.

After the signature associated with the traffic is determined, the signature associated with the traffic is compared in step **421** by the USB hub device to signatures identified, or otherwise know, as being associated with unsafe content. Signatures identified as being unsafe may be obtained from any suitable database or repository of known unsafe content.

A determination is made in step **425** as to whether the signature associated with the traffic indicates that the traffic is unsafe. That is, it is determined if the signature associated with the traffic effectively matches a signature known to be associated with unsafe content. If the determination is that the signature associated with the traffic does not indicate that the traffic is unsafe, the indication is that the traffic is safe. As such, process flow moves from step **425** to step **429** in which the traffic is forwarded by the USB hub device, e.g., to the end-user system or to the USB media device, as appropriate.

Once the traffic, i.e., safe traffic, is forwarded, it is determined in step **437** whether additional traffic is detected. If it is determined that additional traffic is detected the process flow returns to step **417** in which a signature associated with the additional traffic is determined by the USB hub device. Alternatively, if the determination is that additional traffic is not detected, the method of monitoring and filtering USB network traffic is completed.

Returning to step **425**, if it is determined that the signature associated with the traffic indicates that the traffic is unsafe, then the traffic is not forwarded by the USB hub device **433**. In one embodiment, not forwarding the traffic may include providing an indication that the traffic is unsafe. For example, the USB hub device may provide the end-user system with an indication that the USB media drive attempted to load unsafe content onto the end-user system, or the USB hub device may provide the USB media drive with an indication that the end-user system attempted to load unsafe content onto the USB media drive. From step **433**, process flow moves to step **437** in which it is determined whether additional traffic is detected.

As previously mentioned, functionality which enables unsafe or malicious USB network traffic to be detected prior to being provided to a processing arrangement of an end-user system is not limited to being implemented on a USB hub device. For example, such functionality may be provided on a USB media device, or on an end-user system FIG. **5** is a process flow diagram which illustrates one method of monitoring and filtering USB network traffic using a USB hub module, e.g., a USB hub module installed on a USB media device, in accordance with an embodiment. A method of monitoring and filtering USB network traffic begins at step **501** in which a USB media device is coupled to an end-user system. Coupling the USB media device, which includes a USB hub module such as USB hub module **208'** of FIG. **2**B in one embodiment, to the end-user system may include coupling a USB connector of the USB media device to a USB receptacle of the end-user system such that the USB media device and the end-user system may communicate on a USB bus. For ease of discussion, the USB hub module is described as being provided on a USB media device. It should be understood, however, that a USB hub module may instead be provided on an end-user system as discussed above with respect to FIG. **2**C.

Once the USB media device and the end-user system are coupled, USB network traffic is detected by the USB hub module in step **513**. In the described embodiment, the USB network traffic detected by the USB hub module is traffic that the USB media device is attempting to send to the end-user system. It should be appreciated, however, that the USB network traffic may instead be traffic that the end-user system is attempting to send to the USB media device.

A signature associated with the USB network traffic is determined or otherwise identified by the USB hub module in step **517**. After the signature associated with the USB network traffic is determined, the signature associated with the USB network traffic is compared, in step **521**, with signatures identified as being unsafe, e.g., signatures of known viruses or malware.

It is determined in step **525** whether the signature associated with the traffic indicates that the traffic is unsafe. In other words, it is determined whether the signature associated with the traffic effectively matches any signatures identified as being unsafe. If the determination in step **525** is that the signature associated with the traffic indicates that the traffic is not unsafe, the implication is that the traffic is safe. Accordingly, process flow moves from step **525** to step **529** in which the traffic is forwarded by the USB hub module. In one embodiment, the USB hub module is located on the USB media device and, as such, traffic is effectively forwarded form the USB media device to the end-user system. In another embodiment, the USB hub module may be located on the end-user system such that traffic is effectively allowed to pass through the USB hub module to a processing arrangement of the end-user system.

Once the traffic is forwarded by the USB hub module, a determination is made in step **527** as to whether additional traffic is detected. If it is determined that additional traffic is detected, then process flow returns to step **517** in which a signature associated with the additional traffic is determined. On the other hand, if it is determined that additional traffic is not detected, than the method of monitoring and filtering USB network traffic is completed.

Returning to step **525**, if the determination is that the signature associated with the traffic indicates that traffic is unsafe, then the traffic is not forwarded by the USB hub module in step **533**. When the USB hub module is located on the USB media drive, then the traffic is prevented from reaching the end-user system. When the USB hub module is located on the end-user system, traffic may be prevented from reaching a processing system of the end-user system. In one embodiment, not forwarding traffic may include providing an indication that unsafe traffic has been detected. After the traffic is not forwarded by the USB hub module, process flow moves to step **537** in which it is determined if additional traffic is detected.

In general, a USB media device is any suitable device which may store content and may communicate using USB communications, e.g., communicate on a USB bus. FIG. **6** is a block diagram representation of a USB media device in accordance with an embodiment. A USB media device **604** includes a storage arrangement **670** and an USB interface **674**. Storage arrangement **670** is arranged to store content, as for example content that may be transmitted on and/or obtained from a USB bus. USB interface **674**, which may include a USB connector or port, is configured to allow USB media device **604** to be coupled to a USB hub device (not shown) or an end-user system (not shown).

Although only a few embodiments have been described in this disclosure, it should be understood that the disclosure may be embodied in many other specific forms without departing from the spirit or the scope of the present disclosure. By way of example, a monitoring device such as a USB hub device has been described as detecting malicious traffic. In addition to detecting malicious traffic, a monitoring device may also detect anomalous traffic and provide warnings relating to the anomalous traffic. That is, in addition to detecting malicious traffic, a monitoring device may detect traffic that is generally identified as unusual and, hence, suspect.

While signatures used to determine whether particular traffic is safe or unsafe have been described as being stored on a monitoring device such as a USB hub device, signatures may instead be obtained by the monitoring device from a source external to the monitoring device as needed. For instance, a monitoring device may access a repository that contains signatures substantially in real-time when the monitoring device is assessing whether traffic contains unsafe content.

USB network traffic may be any traffic, or content, that is transmitted and/or received on a USB bus. Such traffic may generally include data packets, and the data packets may include, but are not limited to including, packets that contain software applications, text, audio, and/or video.

A USB hub device may be implemented using a single integrated circuit chip. For an embodiment in which USB hub functionality is provided in a USB media device, the

USB hub functionality may be provided as a field programmable gate array (FGPA) or as an application specific integrated circuit (ASIC).

While a traffic source has been described as being a USB media drive, it should be appreciated that a traffic source is not limited to being a USB media drive. A traffic source may more generally be any suitable device in a USB class. For example, a traffic source may be a USB mouse or a USB keyboard without departing from the spirit or the scope of the disclosure.

The embodiments may be implemented as hardware, firmware, and/or software logic embodied in a tangible, i.e., non-transitory, medium that, when executed, is operable to perform the various methods and processes described above. That is, the logic may be embodied as physical arrangements, modules, or components. A tangible medium may be substantially any computer-readable medium that is capable of storing logic or computer program code which may be executed, e.g., by a processor or an overall computing system, to perform methods and functions associated with the embodiments. Such computer-readable mediums may include, but are not limited to including, physical storage and/or memory devices. Executable logic may include, but is not limited to including, code devices, computer program code, and/or executable computer commands or instructions.

It should be appreciated that a computer-readable medium, or a machine-readable medium, may include transitory embodiments and/or non-transitory embodiments, e.g., signals or signals embodied in carrier waves. That is, a computer-readable medium may be associated with non-transitory tangible media and transitory propagating signals.

The steps associated with the methods of the present disclosure may vary widely. Steps may be added, removed, altered, combined, and reordered without departing from the spirit of the scope of the present disclosure. Therefore, the present examples are to be considered as illustrative and not restrictive, and the examples is not to be limited to the details given herein, but may be modified within the scope of the appended claims.

What is claimed is:

1. A method comprising:

obtaining, at a hub device, at least one packet from a first element, the at least one packet being obtained on a Universal Serial Bus (USB) bus, wherein the at least one packet is intended for a second element;

processing, at the hub device, the at least one packet to determine whether the at least one packet is associated with unsafe content;

providing the at least one packet from the hub device to a processing arrangement of the second element if it is determined that the at least one packet is not associated with the unsafe content, wherein the at least one packet is provided to the second element on the USB bus;

blocking the at least one packet from being provided to the processing arrangement of the second element when it is determined that the at least one packet is associated with the unsafe content; and

providing an indication to the second element when it is determined that the at least one packet is associated with the unsafe content, wherein the indication is arranged to indicate that the first element is attempting to provide the unsafe content to the second element.

2. The method of claim **1** wherein the first element is a USB media device and the second element is an end-user system, and wherein the end-user system includes a USB host controller.

3. The method of claim **2** wherein the hub device is coupled between the USB media device and the end-user system.

4. The method of claim **1** wherein processing the at least one packet to determine whether the packet is associated with unsafe content includes identifying a signature associated with the at least one packet and determining whether the signature associated with the at least one packet identifies the at least one packet as having the unsafe content.

5. The method of claim **4** wherein determining whether the signature associated with the at least one packet identifies the at least one packet as having the unsafe content includes obtaining a set of signatures associated with known unsafe content and comparing the signature associated with the at least one packet to the set of signatures.

6. The method of claim **1** wherein the first element is a storage arrangement of a USB media device, and wherein the at least one packet is obtained on the USB bus by the hub device included in the USB media device.

7. The method of claim **1** wherein the at least one packet is obtained on the USB bus by the hub device of a computing device, the computing device including the second element, the second element being a USB host controller.

8. A tangible, non-transitory computer-readable medium comprising computer program code, the computer program code, when executed, configured to:

obtain, at a hub device, at least one packet from a first element, the at least one packet being obtained on a Universal Serial Bus (USB) bus, wherein the at least one packet is intended for a second element;

process, at the hub device, the at least one packet to determine whether the at least one packet is associated with unsafe content;

provide the at least one packet from the hub device to a processing arrangement of the second element if it is determined that the at least one packet is not associated with the unsafe content, wherein the at least one packet is provided to the second element on the USB bus;

block the at least one packet from being provided to the processing arrangement of the second element when it is determined that the at least one packet is associated with the unsafe content; and

provide an indication to the second element when it is determined that the at least one packet is associated with the unsafe content, wherein the indication is arranged to indicate that the first element is attempting to provide the unsafe content to the second element.

9. The tangible, non-transitory computer-readable medium comprising computer program code of claim **8** wherein the first element is a USB media device and the second element is an end-user system, and wherein the end-user system includes a USB host controller.

10. The tangible, non-transitory computer-readable medium of claim **8** wherein the hub device is coupled between the USB media device and the end-user system.

11. The tangible, non-transitory computer-readable medium comprising computer program code of claim **8** wherein the computer program code configured to process the at least one packet to determine whether the packet is associated with unsafe content is further configured to identify a signature associated with the at least one packet and to determine whether the signature associated with the at least one packet identifies the at least one packet as having the unsafe content.

12. The tangible, non-transitory computer-readable medium comprising computer program code of claim **11** wherein the computer program code configured to determine whether the signature associated with the at least one packet identifies the at least one packet as having the unsafe content is further configured to obtain a set of signatures associated with known unsafe content and to compare the signature associated with the at least one packet to the set of signatures.

13. An apparatus comprising:

a processing arrangement;

a communications interface, the communications interface being configured to interface with a Universal Serial Bus (USB) device and an end-user system, the communications interface further being configured to intercept traffic from at least one of the USB media device and the end-user system from a USB bus; and

logic, the logic being operable to determine whether the traffic includes unsafe content, wherein the logic is operable to provide the traffic to a destination on the USB bus when it is determined that the traffic does not include the unsafe content, and wherein the logic is further operable to block the traffic from being provided by the apparatus to the destination when it is determined that the traffic includes the unsafe content; wherein the logic operable to determine whether the traffic includes the unsafe content is further operable to identify a first signature associated with the traffic and to compare the first signature to at least one signature associated with known unsafe content.

14. The apparatus of claim **13** wherein the apparatus is a USB hub device, the destination includes a USB host controller, and the USB media device is a flash drive.

15. An apparatus comprising:

a processing arrangement;

a communications interface, the communications interface being configured to interface with a Universal Serial Bus (USB) device and an end-user system, the communications interface further being configured to intercept traffic from at least one of the USB media device and the end-user system from a USB bus;

logic, the logic being operable to determine whether the traffic includes unsafe content, wherein the logic is operable to provide the traffic to a destination on the USB bus when it is determined that the traffic does not include the unsafe content, and wherein the logic is further operable to block the traffic from being provided to the destination when it is determined that the traffic includes the unsafe content, wherein the logic operable to determine whether the traffic includes the unsafe content is further operable to identify a first signature associated with the traffic and to compare the first signature to at least one signature associated with known unsafe content, wherein the logic operable to block the traffic from being provided to the destination when it is determined that the traffic includes the unsafe content is operable to block the traffic from being provided to the destination when the first signature matches the at least one signature; and

a data store, the data store being configured to store the at least one signature associated with the known unsafe content, wherein the logic operable to compare the first signature to the at least one signature associated with the known unsafe content is further operable to obtain the at least one signature associated with the known unsafe content from the data store.

16. The apparatus of claim **15** wherein the destination is the end-user system.

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